Cognitive Auditory Evoked Potentials: Advances and Insights in Neuroaudiology

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Clinicians can now assess the peripheral auditory pathway with fair precision and reliability. There are psychoacoustic methods, such as pure-tone and speech audiometry, physiological methods, such as otoacoustic emissions and immittance measures, and electrophysiological techniques such as auditory brainstem response. However, it is in the auditory cortex that auditory and language neuroprocessing takes place. Auditory event-related potentials (AERPs), interpreted via cognitive psychophysiology, provide a theoretical rationale for assessing and investigating auditory linguistic neuroprocessing. This is important when we wish to consider clinical conditions which display language and auditory processing impairments, such as certain neurodevelopmental disorders.

AERPs are changes in the ongoing EEG which are time- and phase-locked. They reflect sensory central processing and cognitive activity, which might involve memory, expectation, attention, or changes in mental state. AERPs are one of the most informative, dynamic, and non-invasive methods for studying cognition and the dynamics of neural systems. They provide a continuous measure of processing between stimulus and response, revealing neural reactions not evident in behavior. Processing can also be measured under conditions that do not normally involve a behavioral response, and under some conditions neural systems can be identified. Moreover, its high temporal resolution (milliseconds) facilitates capture and study of neural processes such as auditory and language processing.

Here we draw attention to achievements in understanding the neurofunctional meaning of each AERP component. N1 reflects pre-attentive discrimination and early synchronization between primary and secondary auditory cortices in the lateral and supratemporal planum (Liasis et al., 2006). The significance of P2 is largely unknown, but it is reduced in schizophrenia (Salisbury et al., 2010). The N2 (N2b) is interpreted as a correlate of the controlled detection of stimulus changes and phonological categorization (Amenedo & Díaz, 1998). MMN currently provides an objective measure of auditory perception and discrimination based on the presence of short-term memory (sensory memory; Näätänen, 2001). P3a is related to the engagement of attention, especially orienting, involuntary shifts to changes in the environment, and the processing of novelty (Donchin, 1981). P3b is widely studied in terms of information processing, decision making, and can even measure how demanding a task is cognitively (Polich, 2007).

Other AERPs peaking after 300 ms are widely studied as endogenous language-related components, and are not studied with auditory oddball. The N400 response is seen in response to all meaningful or potentially meaningful stimuli, thus indexing semantic processing (Kutas & Hillyard, 1980). Lastly, the P600 or syntactic positive shift (SPS) is a late centroparietal positivity associated with the processing of syntactic anomalies (Friederici, 1995). A fundamental goal is understanding the basic neural processes which underpin more complex cognitive systems and operations. In terms of assessing central auditory processing, audiology can contribute significantly to cognitive neuroscience.